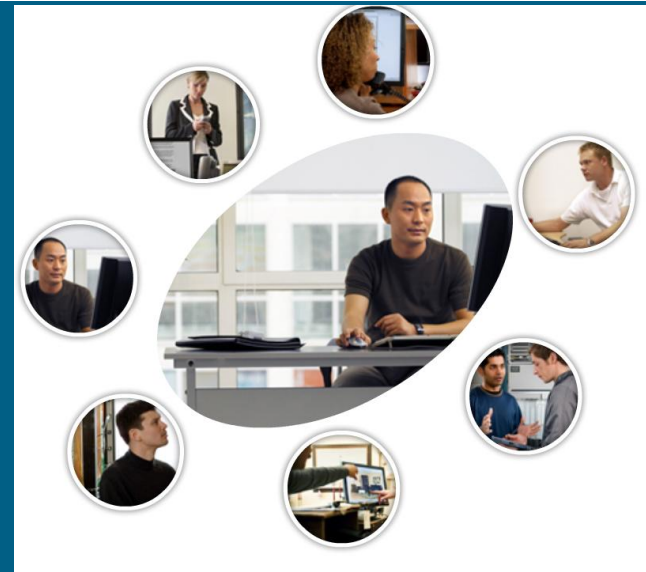# Point-to-Point Protocol (PPP)

Accessing the WAN – Chapter 2

Objectives

- Describe the fundamental concepts of point-to-point serial communication including TDM, demarcation point, DTE-DCE functions, HDLC encapsulation, and serial interface troubleshooting.

- Describe PPP concepts including PPP layered architecture, PPP frame structure, PPP session establishment, multiprotocol encapsulation support, link control protocol (LCP), network control protocol (NCP), and Internet Protocol Control Protocol (IPCP).

- Configure PPP on a serial interface including enabling PPP encapsulation, verifying the PPP connection and troubleshooting encapsulation problems.

- Configure PPP authentication including explaining PAP and CHAP authentication protocols, configuring PPP authentication using PAP and CHAP, and troubleshooting PPP authentication problems.

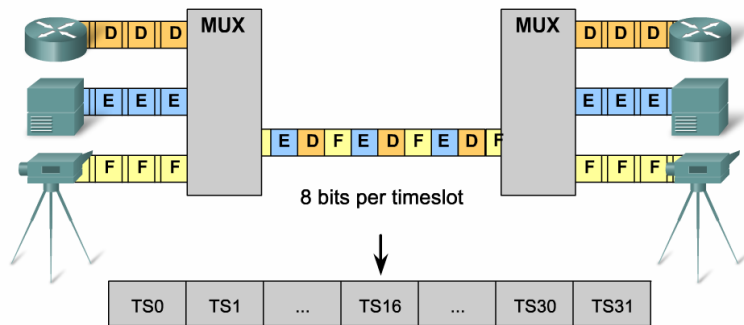# Describe the Fundamental Concepts of Point-to-Point Serial Communication

- Describe the concept of serial communication as the basis of WAN technologies
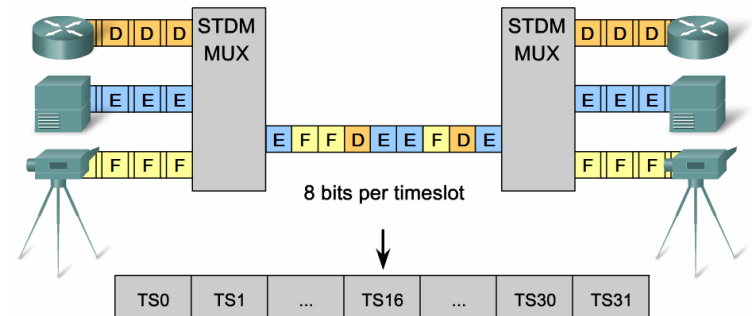
Serial and Parallel Communication
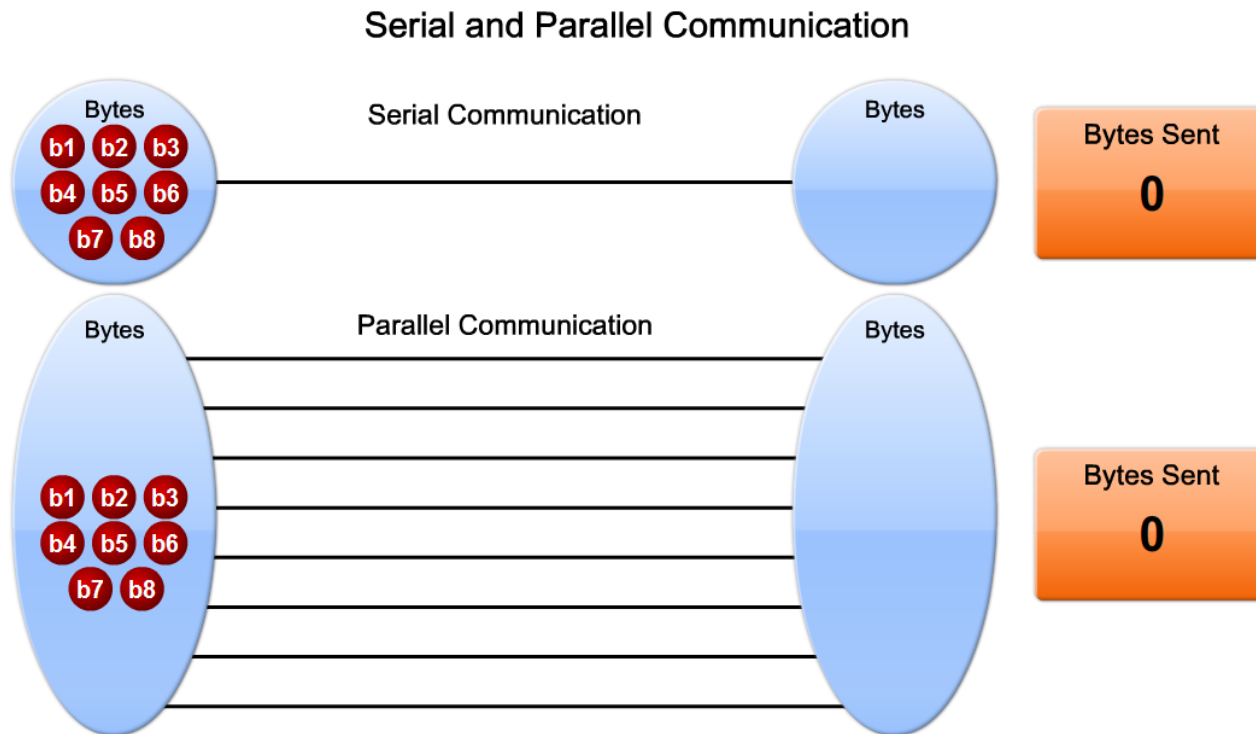
Describe the Fundamental Concepts of Point-to-Point Serial Communication

- Explain how two or more data streams are transported across a single physical connection using TDM

Time Division Multiplexing

8 bits per timeslot

| TS0 | TS1 | ... | TS16 | ... | TS30 | TS31 |

- TDM shares available transmission time on a medium by assigning timeslots to users.
- The MUX accepts input from attached devices in a round-robin fashion and transmits the data in a never-ending pattern.
- T1/E1 and ISDN telephone lines are common examples of synchronous TDM.

Statistical Time Division Multiplexing

8 bits per timeslot

| TS0 | TS1 | ... | TS16 | ... | TS30 | TS31 |

Describe the Fundamental Concepts of Point-to-Point Serial Communication

- Define the location of the demarcation point relative to customer and service provider networks

Demarcation Point
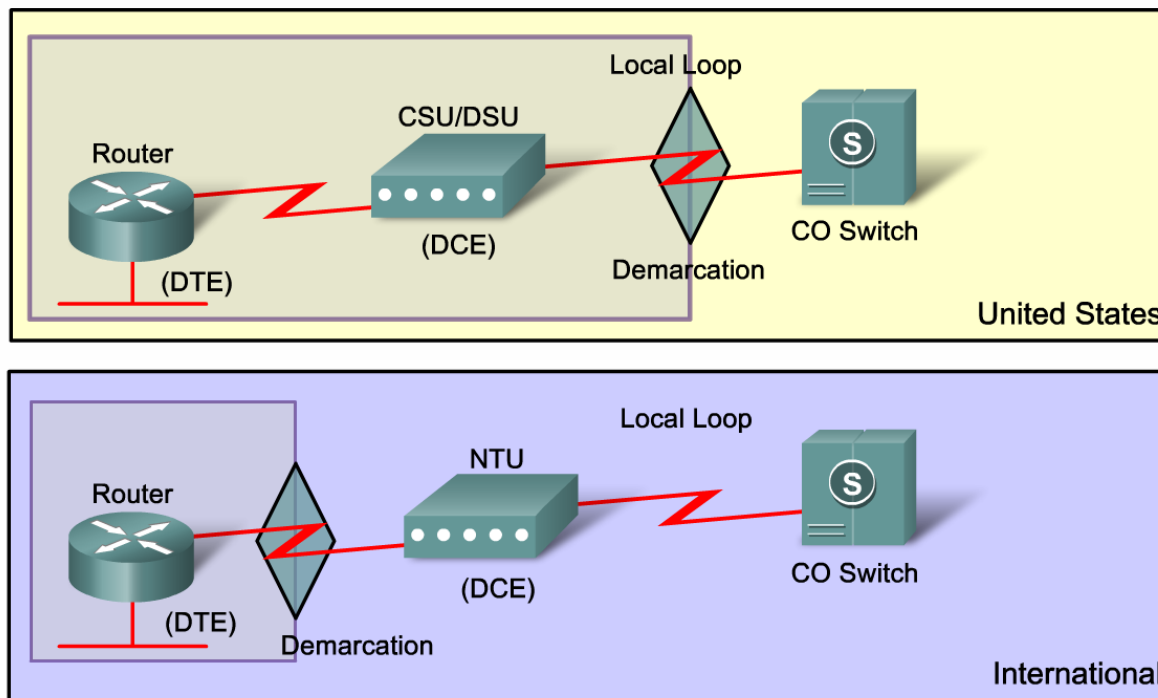
Describe the Fundamental Concepts of Point-to-Point Serial Communication

- Explain the terms DTE and DCE with relative to the location of devices in a network

Serial DCE and DTE WAN Connections

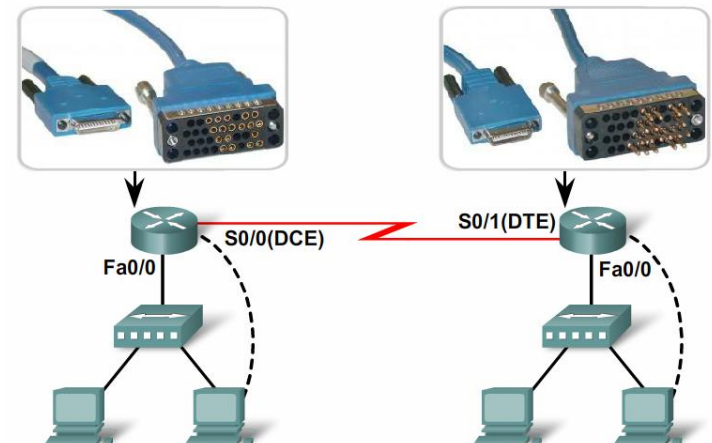| DTE | DCE | | DCE | DTE |

Data Terminal Equipment:
- End of the user's device on the WAN Link

Data Communications Equipment:
- End of the WAN provider's side of the communication facility
- Responsible for providing clocking signal

Smart Serial Connector

Serial WAN Connections in the Lab
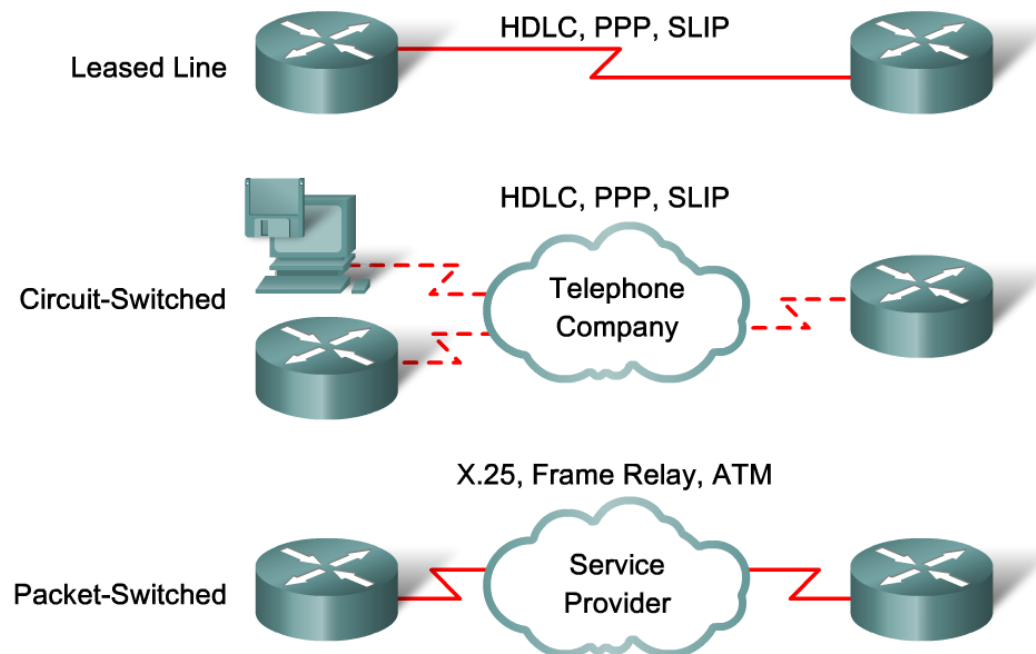
S0/1(DTE)
S0/0(DCE)
Fa0/0
Fa0/0

Describe the Fundamental Concepts of Point-to-Point Serial Communication

- Describe how high-level data link control (HDLC) uses one of three frame types to encapsulate data

WAN Encapsulation Protocols

Describe the Fundamental Concepts of Point-to-Point Serial Communication

- Explain when and how to configure HDLC encapsulation on a router

Configuring HLDC Encapsulation

```
Router(config-if)#encapsulation hdlc
```

- Enable HDLC encapsulation
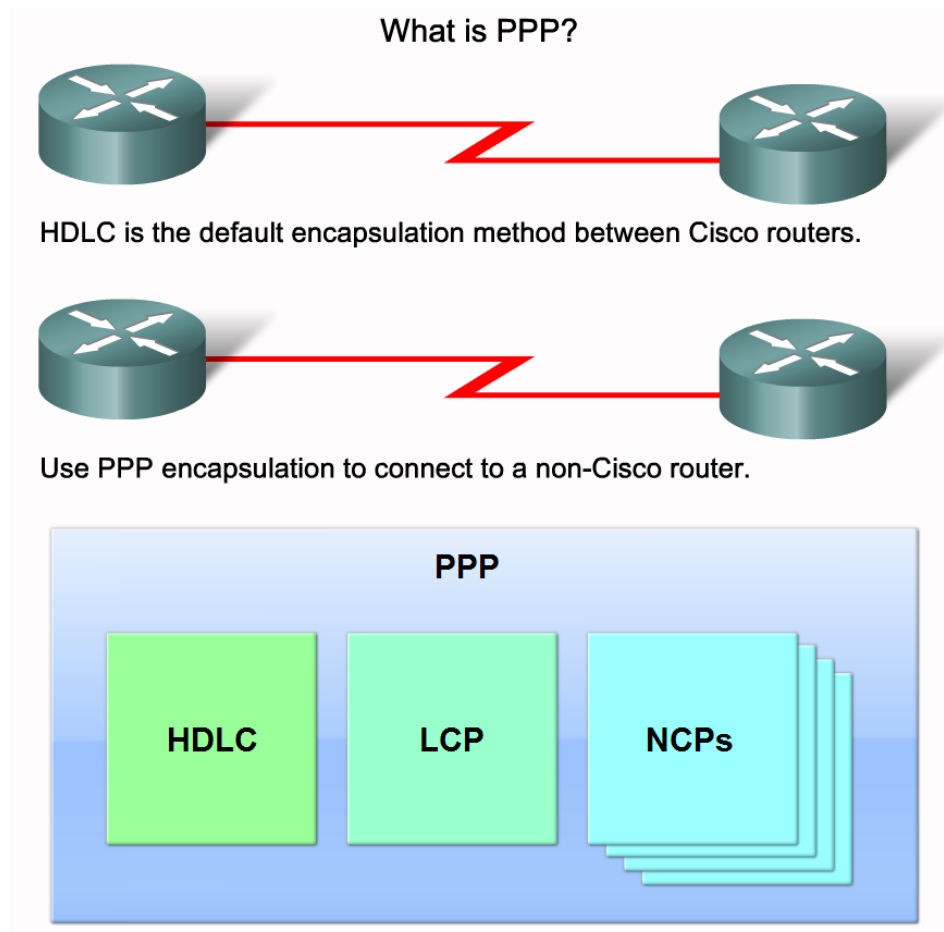- HDLC is the default encapsulation on synchronous serial interfaces

Describe the Fundamental Concepts of Point-to-Point Serial Communication

- Describe the procedure to follow when troubleshooting a serial connection

Troubleshooting a Serial Interface

Status Line	Possible Condition	Problem / Solution
Serial x is up, line protocol is up	This is the proper status line condition.	No action is required.
Serial x is down, line protocol is down (DTE mode)	The router is not sensing a CD signal, which means the CD is not active. A WAN carrier service provider problem has occurred, which means the line is down or is not connected to CSU/DSU. Cabling is faulty or incorrect. Hardware failure has occurred (CSU/DSU).	1. Check the LEDs on the CSU/DSU to see whether the CD is active, or insert a breakout box on the line to check for the CD signal. 2. Verify that the proper cable and interface are being used by looking at the hardware installation documentation. 3. Insert a breakout box and check all control leads. 4. Contact the leased-line or other carrier service to see whether there is a problem. 5. Swap faulty parts. 6. If faulty router hardware is suspected, change the serial line to another port. If the connection comes up, the previously connected interface has a problem.
Serial x is up, line protocol is down (DTE mode)	A local or remote router is misconfigured. Keepalives are not being sent by the remote router. A leased-line or other carrier service problem has occurred, which means a noisy line or misconfigured or failed switch. A timing problem has occurred on	1. Put the modem, CSU, or DSU in local loopback mode and use the `show interfaces serial` command to determine whether the line protocol comes up. If the line protocol comes up, a WAN carrier service provider problem or a failed remote router is the likely problem. 2. If the problem appears to be on the remote end, repeat Step 1 on the remote modem, CSU, or DSU. 3. Verify all cabling. Make certain that the cable is attached to the correct interface, the correct CSU/DSU, and the correct

# Describe Point-to-Point Concepts

- Describe PPP in terms of its use in WAN links

What is PPP?

HDLC is the default encapsulation method between Cisco routers.

Use PPP encapsulation to connect to a non-Cisco router.

PPP

HDLC   LCP   NCPs

Describe Point-to-Point Concepts

- Describe the general function of each layer of PPP architecture

PPP Layered Architecture: Physical Layer
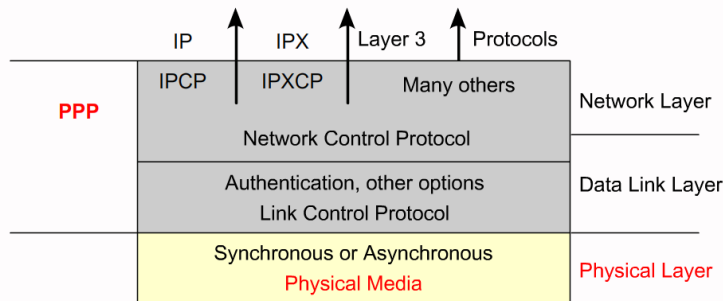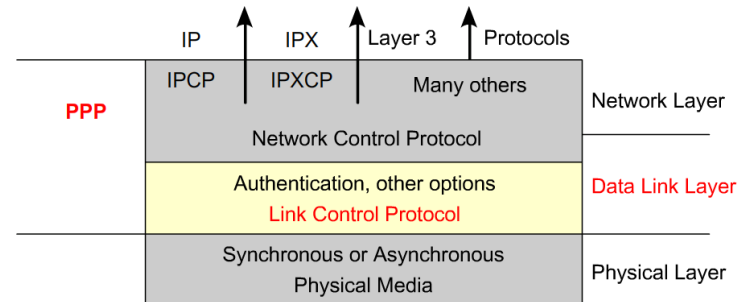
With its lower level functions, PPP can use:
- Synchronous physical media
- Asynchronous physical media like those that use basic telephone service for modem dialup connections

PPP Layered Architecture: LCP Layer

PPP offers service options in LCP and is primarily used for negotiation and frame checking when implementing the point-to-point controls specified by an administrator.
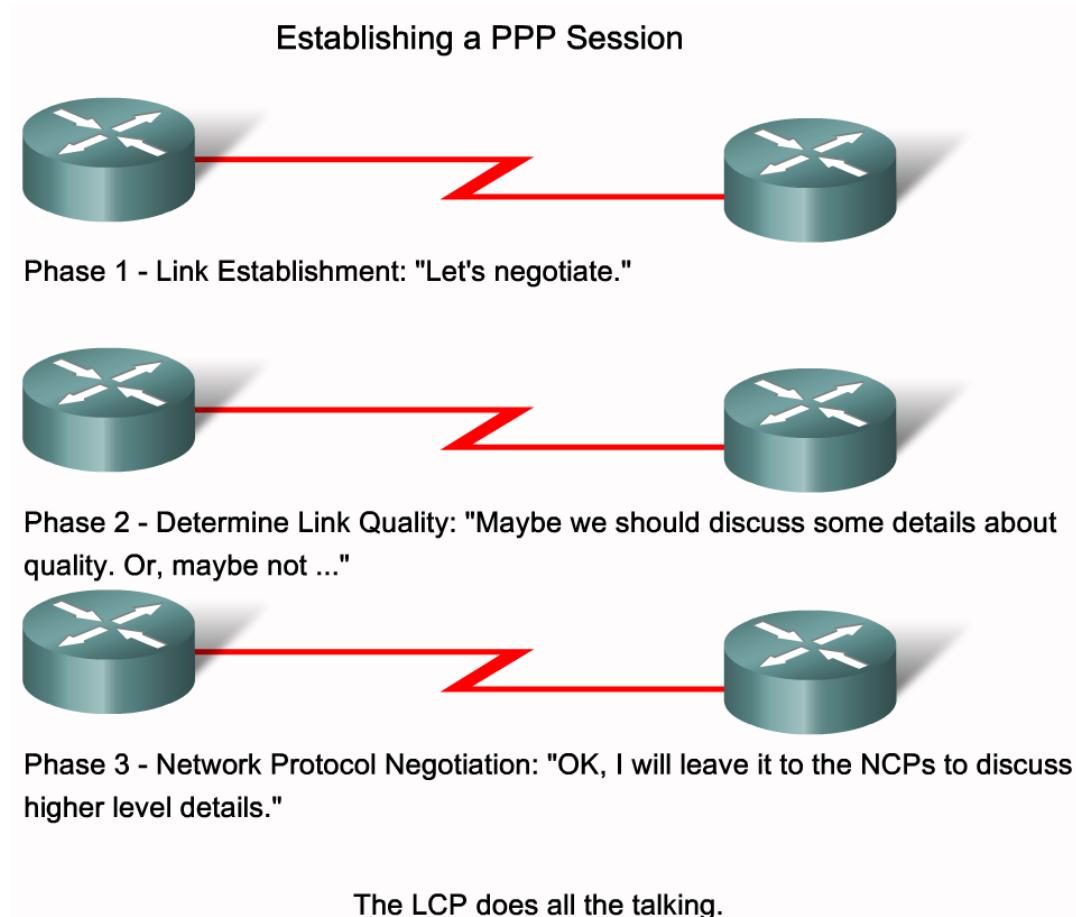
Describe Point-to-Point Concepts

- Describe the purpose and format of each of the fields in a PPP frame

PPP Frame Fields

Field length, in bytes

1	1	1	2	Variable	2 or 4
Flag	Address	Control	Protocol	Data	FCS

Cisco Public

Describe Point-to-Point Concepts

- Define the three phases of PPP session establishment

Establishing a PPP Session

Phase 1 - Link Establishment: "Let's negotiate."

Phase 2 - Determine Link Quality: "Maybe we should discuss some details about quality. Or, maybe not ..."

Phase 3 - Network Protocol Negotiation: "OK, I will leave it to the NCPs to discuss higher level details."

The LCP does all the talking.

Describe Point-to-Point Concepts

- Explain the role of the LCP in PPP

The LCP Link Negotiation Process
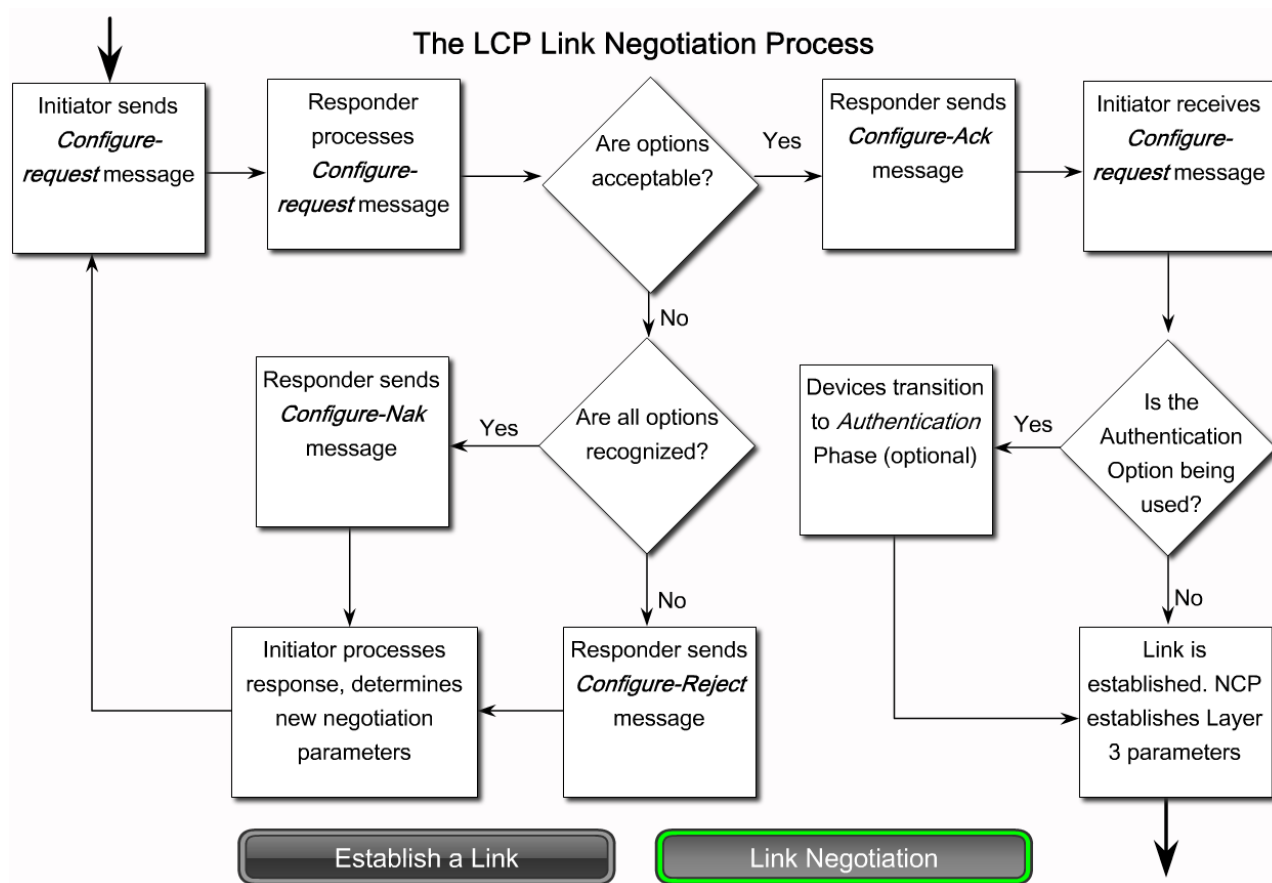
Describe Point-to-Point Concepts

- Describe the characteristics of NCP

NCP Process
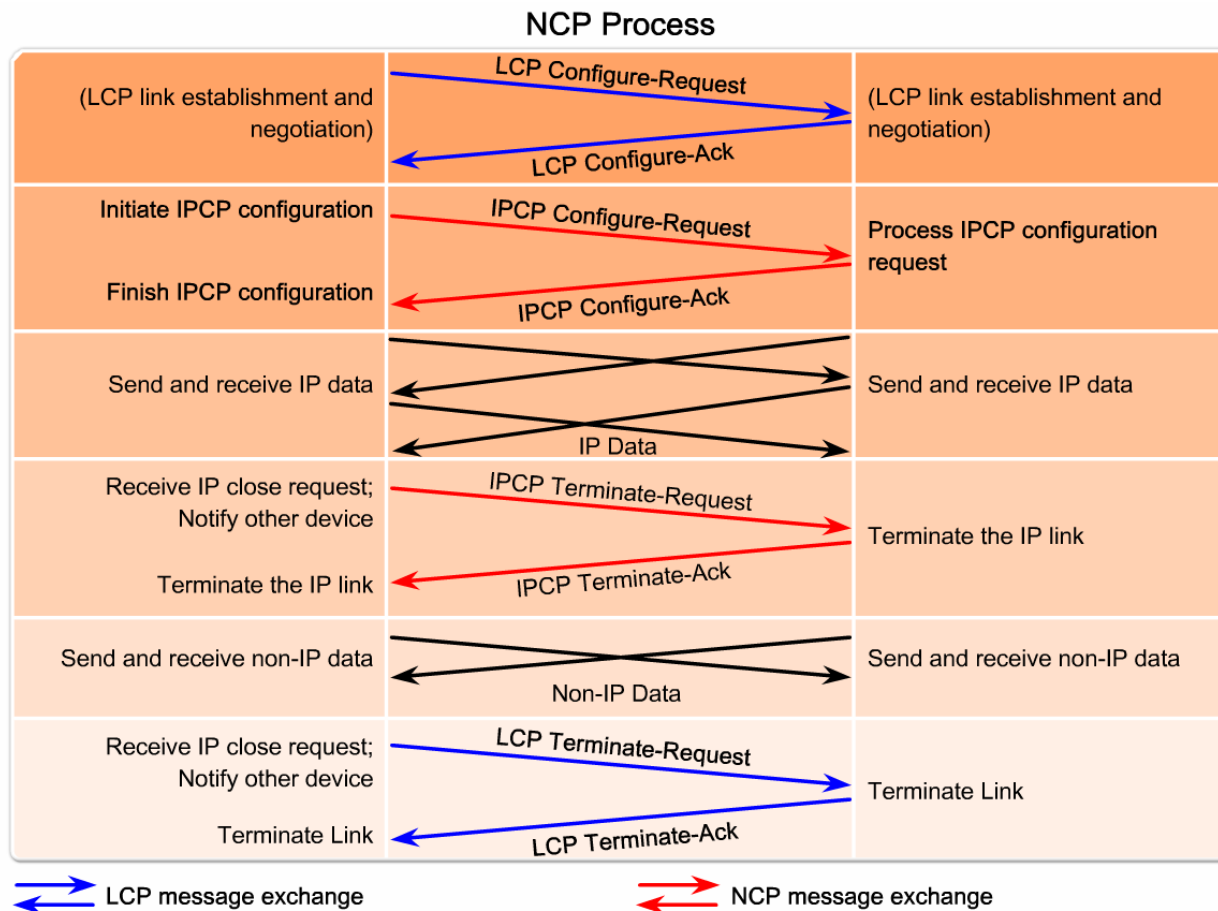
Configure PPP on a Serial Interface

- Describe how configuration options are communicated in the LCP frame

Configurable Options Field Codes

Option Name	Option Type	Option Length	Description
Maximum Receive Unit (MRU)	1	4	MRU is the maximum size of a PPP frame and cannot exceed 65,535. The default is 1,500 and if neither peer is changing the default, it is not negotiated.
Asynchronous Control Character Map (ACCM)	2	6	This is a bit map that enables character escapes for asynchronous links. By default, character escapes are used.
Authentication Protocol	3	5 or 6	This field indicates the authentication protocol, either PAP or CHAP.
Magic Number	5	6	This is a random number chosen to distinguish a peer and detect looped back lines.
Protocol Compression	7	2	A flag indicating that the PPP protocol ID be compressed to a single octet when the 2-byte protocol ID is in the range 0x00-00 to 0x00-FF.
Address and Control Field Compression	8	2	A flag indicating that the PPP Address field (always set to 0xFF) and the PPP Control field (always set to 0x03) be removed from the PPP header.
Callback	13 or 0x0D	3	A 1-octet indicator of how callback is to be determined.

Configure PPP on a Serial Interface

- Explain the purpose of the commands used to configure and verify PPP connections

PPP Configuration Commands

```
Router(config-if)#compress [predictor | stac]
```

Keyword	Description
Predictor	(Optional) Specifies that a predictor compression algorithm will be used.
Stac	(Optional) Specifies that a Stacker (LZS) compression algorithm will be used.

```
Router(config-if)#ppp quality percentage
```

Keyword	Description
Percentage	Specifies the link quality threshold. Range is 1 to 100.

Verifying a Serial PPP Encapsulation Configuration

```
R2#show interface serial 0/0/0
Serial0/0/0 is up, line protocol is up
  Hardware is GT96K Serial
  MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation PPP, LCP Open
  Open: CDPCP, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:07, output 00:00:07, output hang never
  Last clearing of "show interface" counters 00:00:11
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: weighted fair
  Output queue: 0/1000/64/0 (size/max total/threshold/drops)
     Conversations  0/1/32 (active/max active/max total)
     Reserved Conversations 0/0 (allocated/max allocated)
     Available Bandwidth 96 kilobits/sec
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     6 packets input, 76 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     7 packets output, 84 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
     DCD=up  DSR=up  DTR=up  RTS=up  CTS=up
```

Configure PPP on a Serial Interface

- Explain the output of the show interfaces serial command

Practice: Verifying and Debugging Commands

Command	Description
show interfaces	Displays statistics for all interfaces configured on the router or access server
show interfaces serial	Displays information about a serial interface
debug ppp	Debugs PPP
undebug all	Turns off all debugging displays

Configure PPP on a Serial Interface

- Explain the output of the debug ppp command

debug ppp Command Parameters

```
debug ppp {packet | negotiation | error | authentication | compression |
          cbcp}
```

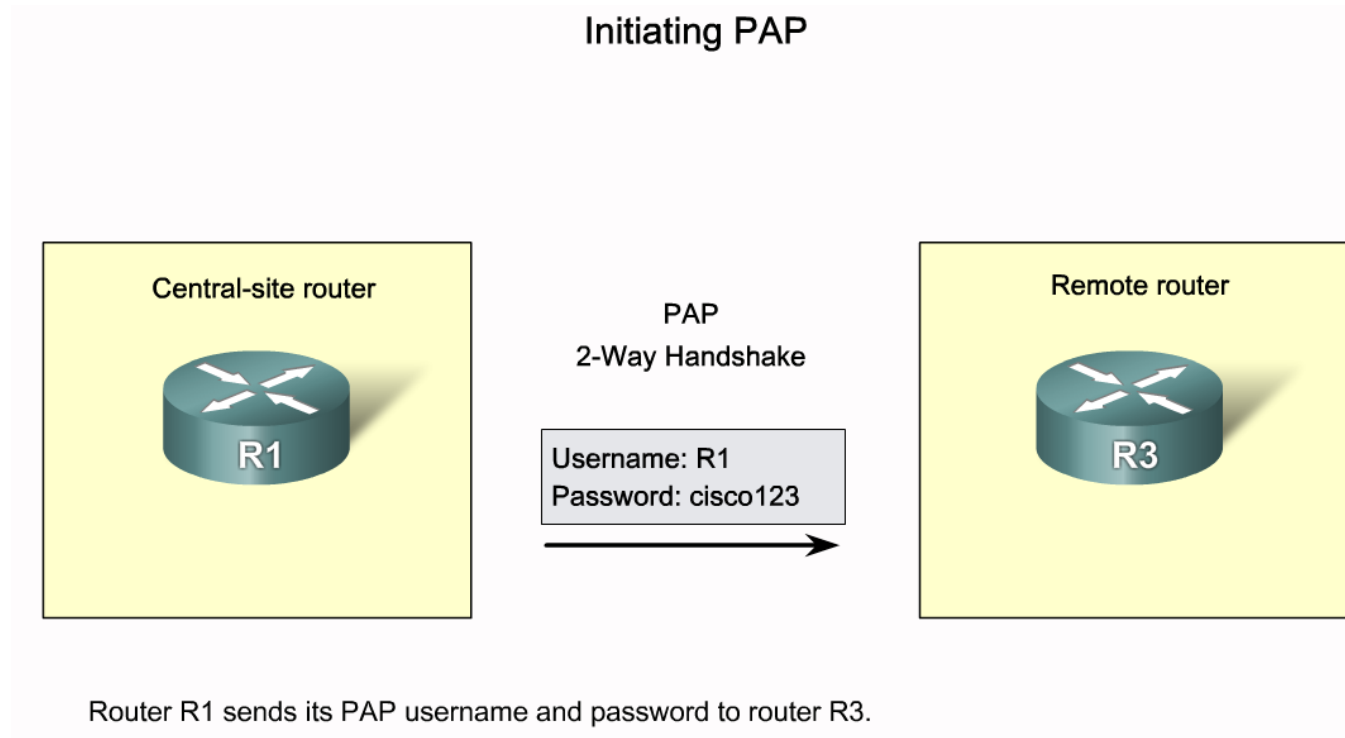| Parameter	Usage
packet	Displays PPP packets being sent and received. (This command displays low-level packet dumps.)
negotiation	Displays PPP packets transmitted during PPP startup, where PPP options are negotiated.
error	Displays protocol errors and error statistics associated with PPP connection negotiation and operation.
authentication	Displays authentication protocol messages, including Challenge Authentication Protocol (CHAP) packet exchanges and Password Authentication Protocol (PAP) exchanges.
compression	Displays information specific to the exchange of PPP connections using MPPC. This command is useful for obtaining incorrect packet sequence number information where MPPC compression is enabled.
cbcp	Displays protocol errors and statistics associated with PPP connection negotiations using MSCB.

Configuring PPP with Authentication

- Differentiate between PAP and CHAP
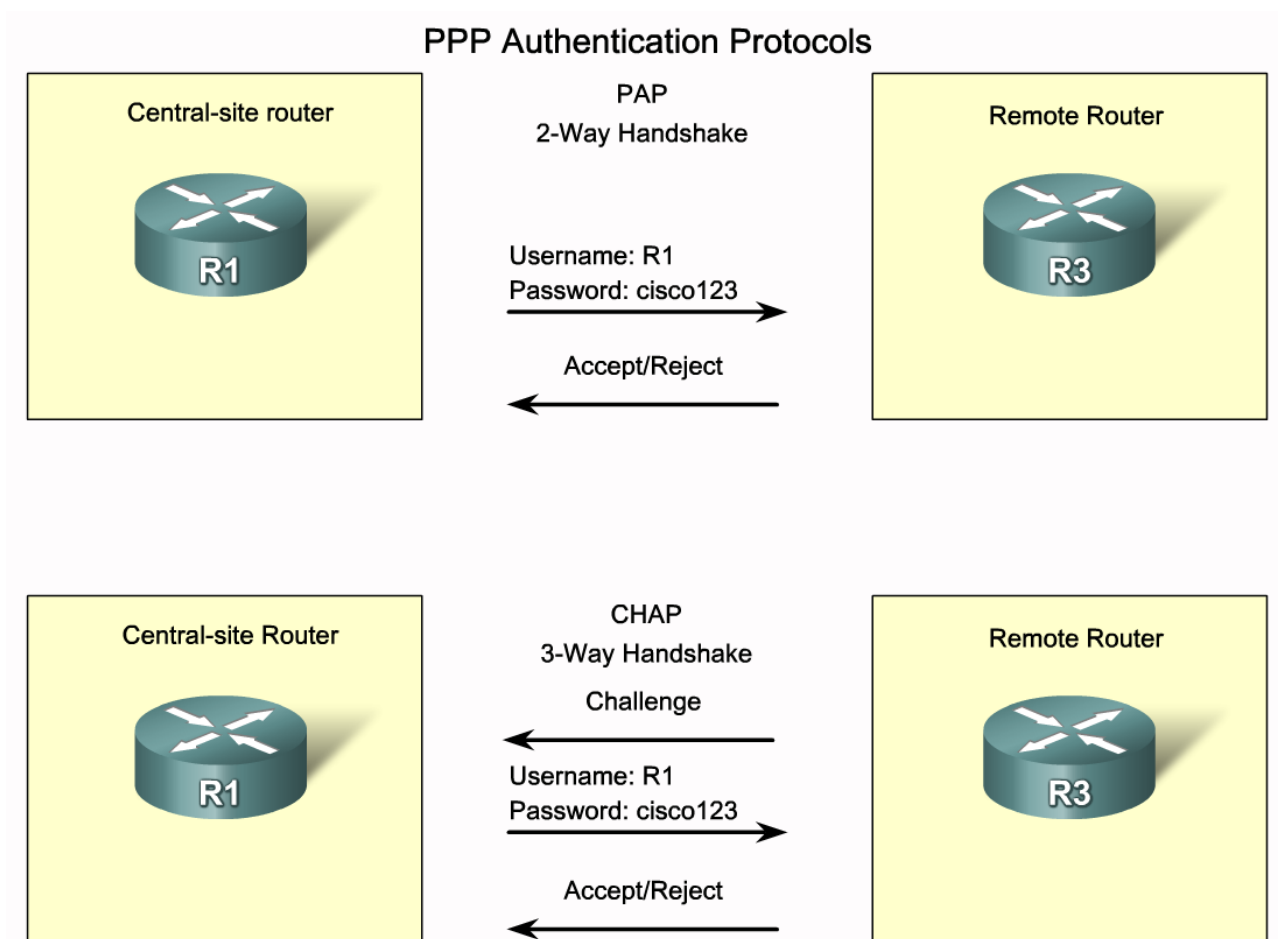
Configuring PPP with Authentication

- Describe how to use PAP to authenticate a PPP connection

Initiating PAP

Central-site router — R1

PAP
2-Way Handshake

Username: R1
Password: cisco123

Remote router — R3

Router R1 sends its PAP username and password to router R3.
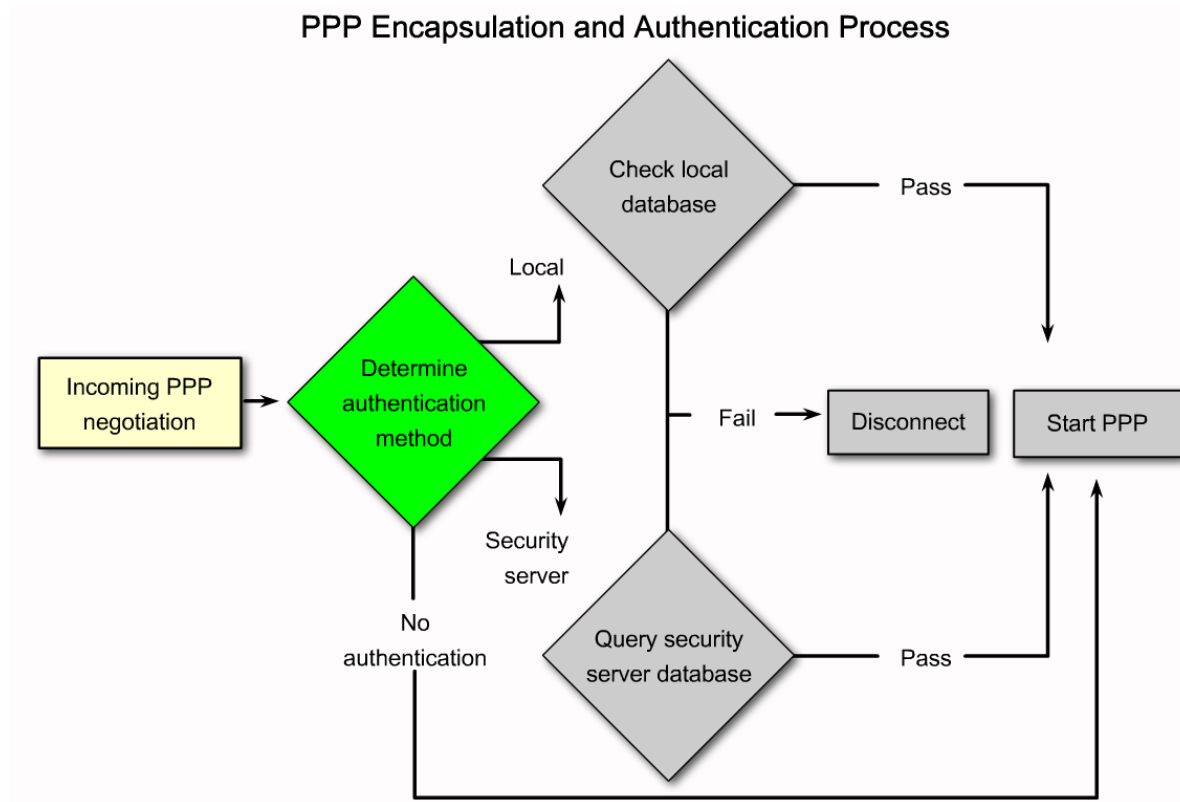
Configuring PPP with Authentication

- Describe how to use CHAP to authenticate a PPP connection

Router R3 initiates the 3-way handshake and sends a challenge message to router R1.

Configuring PPP with Authentication

- Outline the PPP encapsulation and authentication process on a flow chart

PPP Encapsulation and Authentication Process

Configuring PPP with Authentication

- Explain how to configure a PPP connection with authentication

The `ppp authentication` Command

```
ppp authentication {chap | chap pap | pap chap | pap} [if-needed]
[list-name | default] [callin]
```

The ppp authentication Command	
chap	Enables CHAP on a serial interface.
pap	Enables PAP on a serial interface.
chap pap	Enables both CHAP and PAP, and performs CHAP authentication before PAP.
pap chap	Enables both CHAP and PAP, and performs PAP authentication before CHAP.
if-needed (Optional)	Used with TACACS and XTACACS. Do not perform CHAP or PAP authentication if the user has already provided authentication. This option is available only on asynchronous interfaces.
list-name (Optional)	Used with AAA/TACACS+. Specifies the name of a list of TACACS+ methods of authentic list name is specified, the system uses the default. Lists are created with the aaa authentication ppp command.
default (Optional)	Used with AAA/TACACS+. Created with the aaa authentication ppp command.
callin	Specifies authentication on incoming (received) calls only.

Configuring PPP with Authentication

- Explain the output of the debug ppp authentication command

Troubleshooting a PPP Configuration with Authentication

```
R2# debug ppp authentication

Serial0: Unable to authenticate. No name received from peer
Serial0: Unable to validate CHAP response. USERNAME pioneer not found.
Serial0: Unable to validate CHAP response. No password defined for USERNAME pioneer
Serial0: Failed CHAP authentication with remote.
Remote message is Unknown name
Serial0: remote passed CHAP authentication.
Serial0: Passed CHAP authentication with remote.
Serial0: CHAP input code = 4 id = 3 len = 48
```

Summary

- PPP is a widely used WAN protocol

- PPP provides multi-protocol LAN to WAN connections

- PPP session establishment – 4 phases
  - Link establishment
  - Link quality determination
  - Network layer protocol configuration negotiation
  - Link termination

- WAN Encapsulation
  - –HDLC default encapsulation
  - –PPP

Summary

- PPP authentication
    - PAP
        - 2 way handshake
    - CHAP
        - 3 way handshake
    - Use **debug ppp authentication** to confirm authentication configuration

- PPP configuration
    - Done on a serial interface

- After PPP configuration, use show interfaces command to display:
    - LCP state
    - NCP state